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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/729,833	12/06/2000	Pei-Ren Jeng	4425-090	5660

7590

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LOWE HAUPTMAN GILMAN & BERNER, LLP
Suite 310
1700 Diagonal Road
Alexandria, VA 22314

EXAMINER

LEE, HSIEN MING

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 01/29/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/729,833

Applicant(s)

PEI-REN JENG

Examiner

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-50 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-50 is/are rejected.
- 7) ☒ Claim(s) 10,14,17,24,27 and 29 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). ____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Claim Objections

1. Claims 10, 14, 17, 24, 27 and 29 are objected to because of the following informalities: a unit for implantation dose is needed for clarity. Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claim s 31 and 41 recites the limitation "the etched selectivity" in line 2. There is insufficient antecedent basis for this limitation in the claim.

4. Claims 1, 9, 20 and 35 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

"Predetermined region", as recited in claim 1, line 9; claim 9, line 17; claim 20, line 12; claim 35, lines 6-7 ; claim 49, lines 8, 10, 12, 13, is indefinite because one cannot determine an accurate region for the "predetermined region."

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1, 3-5, 9, 49-50 are rejected under 35 U.S.C. 103(a) as obvious over Muller (US 6,207,517) in view of An et al. (US 6,245,618).

Muller teaches the method for forming a dense region of a dielectric layer, comprising:

- providing a substrate 10 (Fig.1a);
- forming a dielectric layer 20 on the substrate 19 (Fig.1a);
- forming and defining a first photoresist layer 30 on the dielectric layer 20 (Fig.1b);
- performing a ion implantation process by the first photoresist layer 30 as a mask to form a dense (implanted) region;
- removing the first photoresist layer 30 (col. 4, lines 62-63);
- forming and defining a second photoresist layer 30' on the dielectric layer 20 to form an etched region 40' having the dense region and a part of the dielectric layer 20 (Fig.1b) ;
- etching the etched region by the second photoresist layer 30' as a etched mask to form a trench while the dense region 40 is removed and to form a via hole while the part of the dielectric layer 20 in the etched region is removed; and
- removing the second photoresist layers 30' to form a pattern 25 in a dual damascene process (Fig.1c; col. 4, lines 62-63);

in which a multiple implantation process is used in the method including three ion implantation steps I_1 , I^2 , I^3 into the dielectric layer 20 with gradually increasing implantation concentration profile (col.5,lines 23-28) as shown in Fig. 2 . The dopant used in the multiple implantation process would include a P or B ion (col.2, lines 40-44).

It would have been obvious to one of the ordinary skill in the art to recognize that the multiple implantation process of Muller is a retrograde implantation process although Muller

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does not literally use the "retrograde implantation process" for forming the dense region (implanted regions). This is further evidenced by An et al. ('618) in which An et al. teaches that the "retrograde implantation process" is a method of forming a gradually increasing impurity concentration region (col. 3, line 54 through col.4, line 2).

7. Claims 2 and 6-8, 10-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Muller ('517) and An et al. ('618) as applied to claims 1 and 9 above, and further in view of Wang et al. (US 6,207,576) and Wu (US 6,127,247).

With respect to claims 6-8, 10, 14 and 17, the combined teachings of Muller ('517) and An et al. ('618) does not teaches that the dielectric layer is a low-K material; and that the retrograde implantation energy is 20~100 KeV for the first step, 350~700 KeV for the second step and 1~3 MeV for the third step; and that the implantation dosage is $10^{12} \sim 10^{15}$.

Wu, however, in a retrograde implantation process teaches the first, second and third energies are 100 ~ 1,000 KeV (col.4, lines 36-42), 500 KeV ~ 5MeV (col.5, lines 15-16) and 200 KeV ~ 3MeV (col. Lines 5, lines 24-25), respectively; and the first, second and third implantation doses are 10^{12} atoms/cm² ~ 10^{13} atoms/cm² (col.4, line42), 5×10^{11} atoms/cm² ~ 10^{15} atoms/cm² (col.5, lines 16-17) and 10^{12} atoms/cm² ~ 5×10^{13} atoms/cm² (col.5, lines 25-26), respectively. Therefore, it would have been obvious to one of the ordinary skill in the art at the time of invention was made to utilize the specific energies and doses as taught by Wu ('247) in 3-step implantation of Muller ('517). The motivation/suggestion for doing so would be to gradually increase the implantation energy from the first step to the third step to create a higher concentration in the predetermined etched region, which would be beneficial to the subsequent etching process.

With respect to claim 2, Wang et al.('576) teaches that a low-K material has been widely used in the semiconductor industry for improving a semiconductor device performance (col.2, lines 60-65). Therefore, it would have been obvious to one of the ordinary skill in the art at the time of invention was made to utilize the low-K dielectric in the combined teachings of Muller ('517) and An et al. ('618) to arrive the claimed invention since it would improve the device performance.

8. Claims 20-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Muller ('517), An et al. ('618), Wang et al. ('576) and Wu ('247).

With respect to claims 20 and 35, Muller ('517) and An et al. ('618) substantially teaches the claimed method as stated above except forming a hard mask over the dielectric layer. Wang et al. ('576) in a method of forming a pattern (trench and via hole) of a dual damascene teaches forming a hard mask 32 over a low-K dielectric 30 (Fig.8). At the time of the invention, it would have been obvious to a person of ordinary skill in the art at the time of the invention was made to incorporate an additional hard mask layer of Wang et al. in Muller's teachings. The suggestion/motivation for doing so would be to protect the underlying dielectric layer during the subsequent etching process.

With respect to the specific implantation energies (claims 23, 35) and dosage (claims 24, 27, 29, 35) in the first, second and third implantation process, Wu in a retrograde implantation process teaches that the first, second and third energies are 100 ~ 1,000 KeV (col.4, lines 36-42), 500 KeV ~ 5MeV (col.5, lines 15-16) and 200 KeV ~ 3MeV (col. Lines 5, lines 24-25), respectively; and the first, second and third implantation dosage are 10^{12} atoms/cm² ~ 10^{13} atoms/cm² (col.4, line42), 5×10^{11} atoms/cm² ~ 10^{15} atoms/cm² (col.5, lines 16-17) and 10^{12}

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atoms/cm² ~ 5 x 10¹³ atoms/cm² (col.5, lines 25-26), respectively. Therefore, it would have been obvious to one of the ordinary skill in the art at the time of invention was made to utilize the specific energies and dosage as taught by Wu ('247) in 3-step implantation of Muller ('517). The motivation/suggestion for doing so would be to gradually increase the implantation energy from the first step to the third step to create a higher concentration in the predetermined etched region, which would be beneficial to the subsequent etching process.

Regarding claim 41, the selection of the etched selectivity between the dense region and the dielectric layer is obvious to one of the ordinary skill in the art because it is a matter of determining optimum process condition by routine experimentation to selectively etch the predetermined etched region without damaging rest portions of the dielectric layer. Furthermore, the specification of the instant invention lacks the criticality as to why the etched selectivity has to be about 2.

Regarding claims 45 and 46, Muller ('517) teaches the first dense (implanted) 40 and second dense (implanted) 40' regions.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on 703-308-4918. The fax phone numbers for the organization where this application or proceeding is assigned is 703-305-0142.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

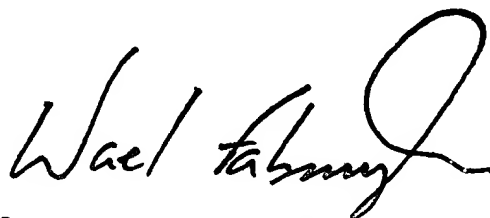
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Hsien Ming Lee
January 24, 2002



SUPERVISORY PRIMARY EXAMINER
TECHNOLOGY CENTER